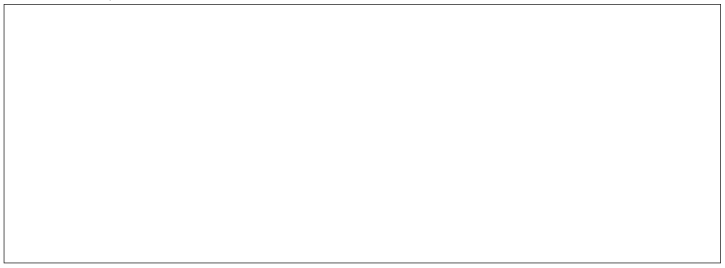
AN INFORMAL PROPOSAL BRIEF

FOR A

LASER DISPLAY FEASIBILITY STUDY



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14 April 1964

LASER DISPLAY FEASIBILITY STUDY PROPOSAL

A laser display feasibility study is proposed. The purpose of this study is to conduct comparative analyses of the various modulation techniques, scanning techniques, screens, and light sources, in order to determine the performance that can presently be obtained and the performance that might be expected in the future. From the results from the study, optimum systems for both the present and the future will be defined.

The three primary applications of interest for the proposed study are: (1) direct display; (2) high resolution read-out; and (3) photographic processing and image enhancement.

For any display device to be used in either of the three applications of interest, four primary components must be considered. These are a light source, a scanning device, a modulator, and a screen. Several types of light sources and several techniques for each of these components are available or are expected to be available in the future. The performance of a display system for any of the three above-mentioned applications of interest is a function of the particular combination of components selected.

The attached figure describes the various interrelationships and possible trade-offs that will be studied.

Existing [redacted] bibliographies on optical modulation, optical scanning, display screen phosphors and lasers will be extended and up-dated. In addition, a survey of the laser and phosphor markets will be made in order to obtain first hand information from researchers and manufacturers in these fields. Information gained through the literature search and survey will be considered during the various trade-off analyses. STAT

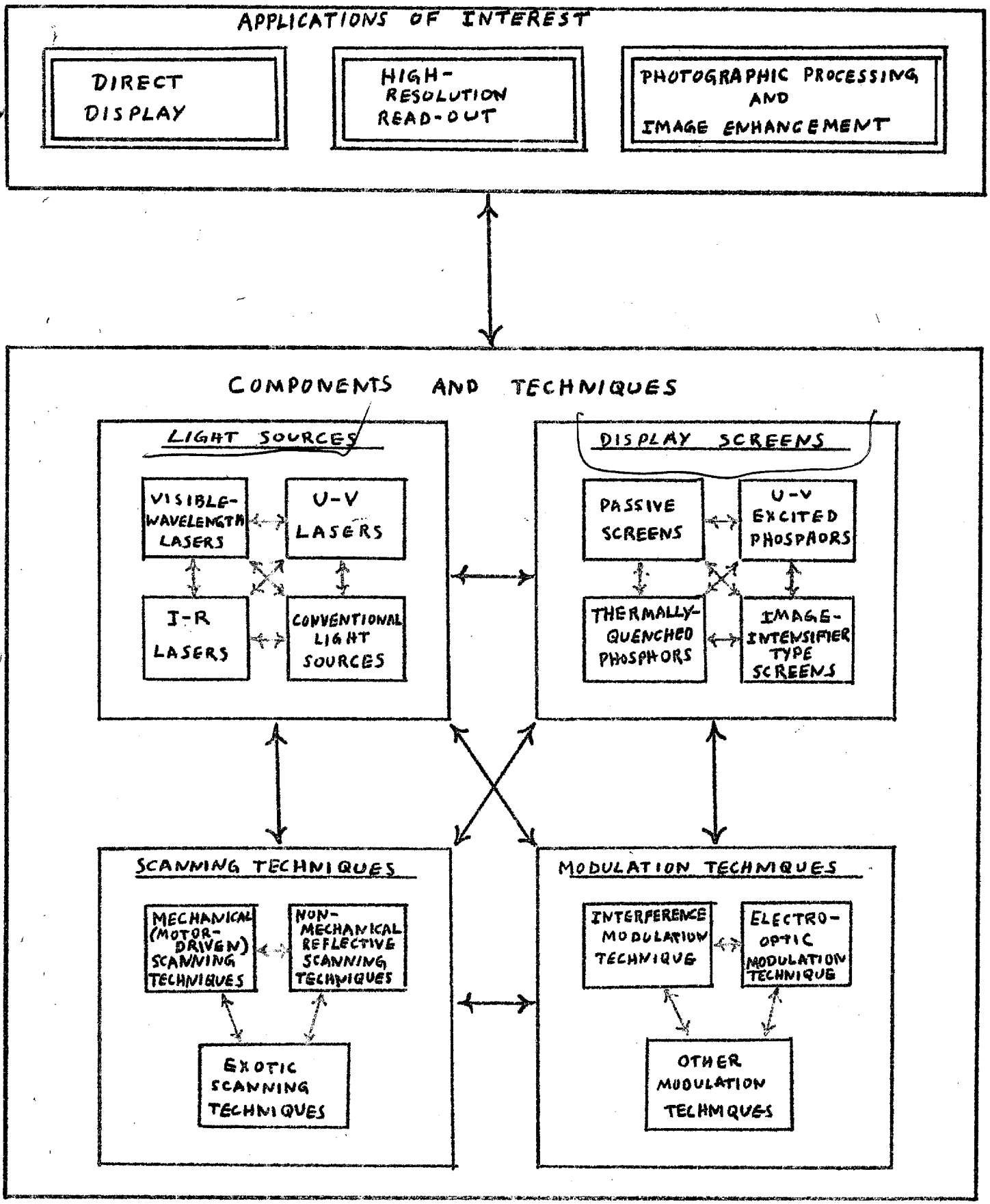
Two basic types of light sources for use in the applications of interest are available. These are: (1) conventional light sources (carbon arc, mercury arc, xenon arc, etc.); and, (2) visible-wavelength and infrared (I-R) lasers. It is possible, however, that an ultra-violet (U-V) laser will be available in the future. Each of these types of light sources has certain advantages and disadvantages depending upon the application, the modulation and scanning techniques used, and the particular type of display screen selected. For example, the interference modulation technique will yield a larger modulation factor with U-V lasers than with visible-wavelength lasers. A conventional light source, on the other hand, may yield a much higher level of brightness at the display screen. The proposed program would include a comparative analysis of the possible light sources, thus revealing the relative merits of different light sources when used with various scanning techniques, modulation techniques and screens. The analyses should also reveal any advantages to be gained by using future lasers such as U-V lasers and more powerful visible or IR lasers.

A study and comparative analysis of mechanical scanners and the more exotic scanning techniques will be performed. Computations will be made to determine the resolution and information rate offered by each of the scanning techniques for each area of application.

The performance of modulators will be studied for various modulation techniques, such as interference modulation, electro-optic modulation, and others. The type of light source as well as the area of application will be considered.

Three basic types of screens may be used with the display techniques considered here. These are: (a) passive screens, where no image retention is provided and integration of the information displayed must be performed by the eye or recording film. (b) Phosphor screens which provide image retention. This type of screen is of great interest, especially for use with the U-V lasers. For use with visible-wavelength and IR lasers, thermally quenched phosphors will be considered. (c) The possibility of using an image-intensifier type of screen in conjunction with laser displays will be studied. This type of screen could yield a black and white display as well as light amplification. For example, a large screen consisting of two parallel glass plates, one coated with an S-20 photo-cathode material and the other coated with a P-4 phosphor, might be used. The plates could be very closely spaced, resulting in a low voltage requirement to produce the necessary field. The resolution, image brightness and decay times for screens of this type will be considered.

A final report will be prepared showing the results of the study. Based on information gained during the studies, two system configurations will be defined: an optimum system using presently available lasers and techniques; and an optimum system using expected future lasers and techniques. The results of the study will be compiled in such a way as to allow an optimum display system design analysis to be immediately performed for any of the applications of interest.



⟷ Indicates interrelationships between COMPONENTS & TECHNIQUES and APPLICATIONS.

⟷ Indicates proposed trade-off studies.

LASER DISPLAY FEASIBILITY STUDY

STATEMENT OF WORK

I. General

Conduct a study of the feasibility of laser systems for performing certain display functions presently performed by cathode-ray-tube (CRT) systems. A portion of the study will be devoted to a study of the interrelationships between various laser-system components, and the effects on these interrelationships when various techniques are utilized in each of the components. Also, conduct trade-off studies to determine the optimum combination of techniques and components for both present and future laser display systems for the following applications:

(1) Direct display
(2) High-resolution read-out
(3) Photographic processing and image enhancement.

II. Literature Search

Conduct a literature search in the areas of:

(1) Optical Modulation
(2) Optical Scanning
(3) Phosphors
(4) Lasers

III. Light-Sources Study

Conduct a survey of lasers and conventional light sources and determine expected characteristics of future lasers and when such lasers will become available.

Compare the characteristics of visible-wavelength lasers, U-V lasers, and conventional light sources, and study the relative advantages of each of these when applied to (1) direct displays, (2) high-resolution read-out, and (3) photographic processing and image enhancement. Each of these light sources shall also be studied relative to advantages or disadvantages when used with various modulation and scanning techniques and types of screens.

IV. Scanning Techniques Study

Study and compare the characteristics of mechanical scanners, non-mechanical reflective scanners, and exotic scanning techniques. Through computations, determine the resolution and information rate offered by each of these scanning techniques, and quantitatively compare the techniques.

V. Modulation Techniques Study

D. Conduct a theoretical study of various modulation techniques, such as interference modulation and electro-optic modulation, and determine the relative advantages of each when used with visible-wavelength

lasers, U-V lasers, and conventional light sources. The requirements for modulation bandwidth, modulation factor, etc., for each particular display applications shall be considered.

VI. Screens Study

Conduct trade-off studies for the various types of laser display screens as indicated below:

A. Conduct a study of various passive display screen materials for use in the various applications of interest. Such characteristics as image brightness and maximum possible resolution shall be considered.

B. Conduct a study of phosphors for use with U-V lasers in the applications of interest. Both presently available and expected future phosphors shall be considered. Resolution, decay time, image brightness, and spectral characteristics of the phosphor shall be of primary consideration.

C. Conduct a study of thermally-quenched phosphors for possible use with visible and I-R lasers. Excitation wavelengths, excitation times, decay times, and quenching times shall be considered. The ability of these phosphors to produce image inversion shall also be considered.

D. Determine a near-optimum configuration for an image-intensifier-type display screen. Such factors as spacing of the photocathode and phosphor and type of photocathode and phosphor materials will be considered.

VII. Final Report

Prepare a Final Technical Report giving the results of the above studies and defining optimum systems that may be designed both with presently available components and techniques and with future components and techniques. Present data and conclusions in a form such that a system design analysis may be performed without further study.

VIII. Quarterly Status Reports

Submit informal Quarterly Status Reports at the end of the third and sixth months of the program. These reports shall include the status of the effort, major milestones for the past quarter, and the approach for the next quarter.

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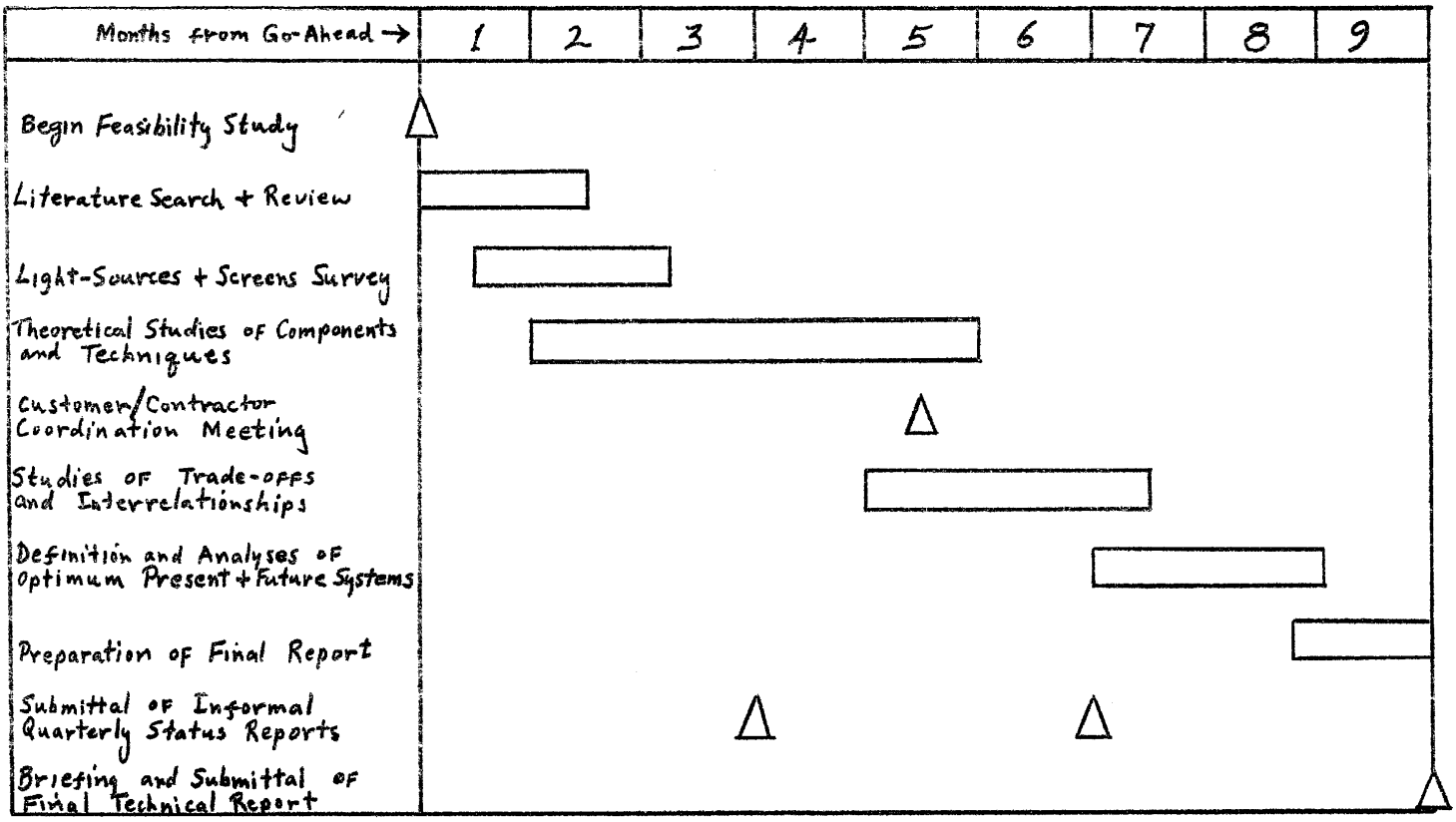
PROGRAM SCHEDULE



LASER DISPLAY FEASIBILITY STUDY

MANPOWER SCHEDULE

DESCRIPTION	MONTHS FROM START (T=0) 1	2	3	4	5	6	7	8	9	TOTAL MH
BEGIN FEASIBILITY STUDY	△									
LITERATURE SEARCH & REVIEW	1½	½								2
LIGHT-SOURCES & SCREENS SURVEY	¾	1	¼							2
THEORETICAL STUDIES OF COMPONENTS AND TECHNIQUES		1½	2½	2¾	1½					8¼
CUSTOMER/CONTRACTOR COORDINATION MEETING.					△					
STUDIES OF TRADE-OFFS AND INTERRELATIONSHIPS					2	3½	1			6½
DEFINITION AND ANALYSES OF OPTIMUM PRESENT & FUTURE SYSTEMS							2½	3		5½
PREPARATION OF FINAL REPORT								½	1½	2
SUBMITTAL OF INFORMAL QUARTERLY STATUS REPORT			△			△				
BRIEFING & SUBMITTAL OF FINAL TECHNICAL REPORT									△	
TOTAL MAN MONTHS	2¼	3	2¾	2¾	3½	3¾	3½	3½	1½	26